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Railroad And Street Grade Crossing
Elimination. Some Problems To Be
Considered By Public Regulating Bodies.

RAILROAD AND STREET GRADE CROSSING
ELIMINATION

SOME PROBLEMS TO BE CONSIDERED
BY PUBLIC REGULATING BODIES

BY

LEVI PATTEN ATWOOD

B. S., UNIVERSITY OF ILLINOIS, 1894

THESIS

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE

DEGREE OF
CIVIL ENGINEER

IN

THE GRADUATE SCHOOL

OF THE

UNIVERSITY OF ILLINOIS

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I HEREBY RECOMMEND THAT THE THESIS PREPARED BY

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RAILROAD AND STREET GRADE CROSSING ELIMINATION—
SOME PROBLEMS TO BE CONSIDERED BY PUBLIC REGULATING BODIES

I. INTRODUCTION.

a. The question of eliminating railroad and street grade crossings is presenting itself in all parts of this country with ever increasing frequency. The spur of actual danger to those who have occasion to use particularly dangerous crossings causes a stream of protest to reach railroad and public officials and public regulating bodies these days; all demanding some measure of protection. To these demands are added the agitation of various groups of citizens as members of local organizations, or of communities, or of political units, all tending to create a public sentiment which insists that the railroads shall do more, and still more, in the matter of protecting or eliminating grade crossings.

b. There are several factors responsible for this question recurring with much increasing insistence. Our railroads are operating more and heavier trains and at higher speeds; and the speed factor becomes more pertinent to this question of safety at crossings with each improvement in track or equipment. At the same time the traffic upon our streets and highways is constantly increasing, due to growing population and to the development of the automobile. Perhaps the automobile is the last word today in explanation of the sentiment which seeks more protection at grade crossings than now exists. With the phenomenal growth of this industry has come a tendency for more people to pass to and

fro along our streets and highways, and at higher speeds and for greater distances than even our forefathers of one generation only ever dreamed of. Unfortunately with this new development has grown a familiarity with high speeds which apparently has diminished that "bump of caution" which the normal human being is supposed to possess. And so, since he individually forgets to exercise a due caution for his own safety while using the public thoroughfares, he, as an individual member of a community, raises his voice in unison with his fellow citizens in public clamor, demanding that the railroads protect him from the necessity of having to use that same "bump of caution" for the purpose of avoiding collisions with railroad equipment.

But the railroads also feel to a considerable degree the need for separation of grades. With the increasing density of railroad traffic and of yard and industry switching, in conjunction with the increasing use of the streets and its consequent interference with operation, accidents to people and property, and damage suits to defend, comes a larger and larger expenditure for the installation of protection devices with the ever attendant maintenance and operation costs.

Records show that the railroads of Wisconsin, acting under orders or requests of the Wisconsin Railroad Commission, had expended or invested in the installation of crossing protection devices, during the eight and one-half years prior to 1914, something like \$200,000 in round numbers. These devices require an annual expenditure for operation and maintenance of approxi-

mately \$37,000. Adding the interest which accrues to the money invested, and these figures would seem to show that, generally speaking, the railroads must provide for an annual expenditure of \$25 for each \$100 invested in crossing protection devices. This annual charge capitalized at five per cent shows that the railroads, from a financial point of view, and provided always that funds were available or obtainable, could afford to invest \$500 in a so-called permanent structure to eliminate a grade crossing for each \$100 required to install a protective device and maintain the crossing.

Furthermore, in some cases, notably in Massachusetts*, the railroads can not lay new or additional tracks across the public highways without special permission of the public service commission. This results in some railroads petitioning for grade separation at times in order to carry out plans for expanding track facilities.

*It should be stated here that the writer, in defining any specific line of action, or duty, or power, of a public regulating body, has in mind the Railroad Commission of Wisconsin, unless otherwise stated.

II. HOW ACCOMPLISHED.

The elimination of grade crossings, either as individual crossings or grouped in a more or less extensive plan of elimination by means of track elevation or depression, may come about in three ways, viz:

a. By the pressure of public sentiment brought to bear upon the railroad. Those cases brought about by city ordinances and because of franchise or charter stipulations will be considered as in this class. Chicago is probably an illustration of the greatest magnitude of results produced in this manner.

b. By reason of the initiative of the railroads themselves. Grade separation has been affected in all parts of the country by this means. In such cases, all or the greater part, of the details may be agreed upon by the parties in interest before the plans are presented to the railroad commission for formal approval. Unfortunately, even when the railroad advocates the elimination, it is sometimes impossible for the parties affected to agree upon the details involved.

c. By orders of a public regulating body, acting either upon petition or upon its own motion. A considerable amount of grade separation has been brought about in the first two ways mentioned, but it is the purpose of this article to consider the cases coming under this class. In so doing it will still be possible to cover the subject, for any problems requiring the attention of the commission which might arise under the first two ways outlined will be similar to problems arising when the

grade separation is affected by order of a commission.

III. THE NECESSITY FOR A PUBLIC REGULATING BODY.

a. The necessity for a public regulating body exists because only too often is it the case that those who anticipate a financial burden or damage if a proposed grade separation scheme is carried out, can not be made to admit that public safety and convenience require such an improvement. In other words, the various interests involved will not all admit that the safety and convenience of the users of the streets and tracks require a separation of grades. Of course there are exceptions and many railroad officials will give all the assistance within their power to obtain the best solution possible for all interests concerned, and not alone for the interests of the railroad. In the same way many city officials and public spirited business men are broad-minded enough to consider the problem in every phase, and not alone as to its effects upon their own interests. However, it must be admitted that the tendency is as first stated, and hence there is a need for a public regulating body to assume jurisdiction in the case and decide if public safety demands a separation of grades.

b. But grant that these interests have admitted this first premise, there arises the problem as to how best to affect such a separation. Shall it be by a full track elevation, or a full track depression, or by a full street elevation or depression, or by a combination of track and street changes? The various parties will probably view the problem in different ways, unduly influenced perhaps by their own individual interests.

Hence there is need of a public regulating body to determine also the mode and manner of affecting a separation of grades.

c. Yet still another uncertain factor presents itself, and it tends usually to keep the various interests from agreeing on the two points just mentioned. It is the uncertainty as to where the financial burden may fall. And again is such a commission needed to decide this question and apportion the cost. It is thus apparent that a commission or regulating body is needed to determine any or all of these three questions.

d. Such a commission is given the power to investigate and act upon its own motion, if necessary, in these matters. It can determine as to the necessity existing, specify the mode and manner and time of performing the work, and decide as to an equitable distribution of the resultant cost among the interests affected, and enforce its orders through the circuit court with the assistance of the Attorney-General. All, of course, subject to review of the court, upon appeal, as to the legality or reasonableness of such order. All orders are in force and are prima facie lawful and reasonable, however, until finally found otherwise in an action brought in a court of competent jurisdiction. In all such trials the burden of proof is upon the plaintiff to show by clear and satisfactory evidence that the order of the commission complained of is unlawful, or unreasonable, as the case may be.

This places the commission in a position to exercise functions of both a legislative and judicial nature. Such a

delegation of authority to one person or political unit probably was not contemplated when the constitution of these United States was framed. The exigencies of our complex development along social, industrial, and political lines have made necessary more effective means of dealing with some of the affairs affecting the public than were provided for in our constitution. Hence the development of federal and state regulating bodies during the last two decades or more. At first acknowledged and accepted as an experiment, the idea has expanded into such a field of usefulness that it will continue to grow and to be still more helpful, unless superseded by government ownership, which is advocated to some extent today.

IV. SOME PROBLEMS TO BE CONSIDERED
AND
THE MANNER OF DEALING WITH THEM

a. Public safety and necessity. If the railroad petitions for grade separation, the question of public safety and convenience may not be expected to require much attention from the commission, for the reason that the community affected undoubtedly will admit that the safety and convenience of its citizens will be benefited by such a separation of grades. On the other hand, if the commission acts upon petition of the city, village, town, or county, or acts upon its own motion, it must determine first that public safety requires a separation of grades.

At first thought it would seem to be easy to determine if a particular crossing exposes users of the street or highway to danger. But the difficulty is that every crossing, when considered by itself, exhibits possibilities of danger to the traveling public. Even without train or traveler in sight, it is a potential danger zone. Who knows that a train and traveler may not inadvertently reach the crossing at the same moment, in which case there is another grade crossing accident added to the already too extensive list of such casualties. No, the adjective safe should not be used in referring to crossings; rather should it be said that they are more or less dangerous, as the case may be. But this leads to only one conclusion, namely, that public safety would be promoted by the elimination of any grade crossing, and if such action were to be determined by this

one question alone, our commissions would be compelled to order all grade crossings eliminated.

Such action would not be considered proper by any body of representative citizens. Physical obstacles and lack of resources prohibit it. For instance, Mr. C. E. Smith, then assistant chief engineer of the Missouri Pacific Railway, stated in an article in Bulletin 16, number 171 of the American Railway Engineering Association, that there are approximately ten thousand grade crossings on that system, and it has been estimated that it would require an expenditure of \$300,000,000 for their elimination. It was further estimated that the interest, taxes, maintenance and depreciation on this improvement would be some twelve per cent, or require an annual expenditure of \$36,000,000. This in turn would call for an increase in gross earnings of some \$144,000,000 per year, or three times the gross earnings of the road at that time. Since such an improvement is not in itself revenue producing, the fallacy of basing any order for extensive grade elimination on the single question of safety is apparent.

Consequently it is deemed expedient to consider some other factors before passing an opinion as to whether public safety requires such a separation of grades. Since some crossings are more dangerous than others, it is customary to consider first the comparative dangers of various crossings. And since some eliminations may be expected to cost more than others it is also often the practice to consider the estimated costs of the

proposed grade separation before passing upon the first point to be determined.

It is essential to know the use made of the crossing, or crossings, in question; the relative locations of highways or streets and of railroad tracks; the grades and widths of the approaches and the grades and alignment of the tracks on either side; and in fact all the topographical conditions of that locality. All of these facts have a bearing on the subject in hand. With a level open country and a highway and a track intersecting at approximately a right angle the least danger presents itself to travelers along the highway. But with a road adjacent to and parallel with a track located in a cut and on a descending grade, all for some little distance before reaching a crossing, there is an entirely different situation to deal with. Such a crossing, so far as physical conditions are concerned, is a much more dangerous one. However, the relative danger is not to be determined alone by the physical conditions. The number of people using a crossing has its effect upon the degree of danger also, as well as being an index to the necessity for a crossing at that point to serve the public.

To ascertain just what use is being made of a crossing, a traffic count and study are made. A count is taken of the pedestrians, vehicles, motor cars, and street cars with its passengers, using the street, together with the number and character of train and engine movements over the crossing. Usually, this information is noted for each separate hour of the count, which

should cover a sufficient interval of time to give a representative indication. It may be for a day, or part of a day only, or it may cover three or more days. Individual judgment and the exigencies of the case usually determine this matter. The inspector will also note the aggregate time during which the gates, if any, are down, and the resulting aggregate delays to street cars as well as to other street traffic, as far as is possible. In many cases the traffic data are secured in a more detailed manner, such as separating the traffic into more classes and by direction, both on street and railroad.

With such traffic data on hand, what use is to be made of them? Some have advocated that grade separation is not required until the traffic reaches certain figures, which figures they themselves desire to specify. However, such data should be used with considerable latitude in so far as they bear upon the necessity for a separation of grades in order to safeguard the public. A careful consideration of accurate traffic data is sometimes helpful in arriving at a determination of relative benefits to be expected from such an improvement, and particularly as affecting the street or interurban railroad interests. While no definite traffic figures can be named by which the commission may be governed in determining for or against a proposed grade crossing elimination, yet there is a density of traffic, which when reached, may be expected to cause both the municipality and the railroad to seek relief. If in a twenty-four hour day there is a density of traffic amounting to anywhere near five

thousand pedestrians, two thousand vehicles and street cars, and two hundred train and engine movements, there may be expected a consensus of opinion as to the need for relief of some character. But many complaints are ordinarily made before traffic over a crossing at grade reaches such figures. From what has been said it will be seen that the commission must consider each case on its own merits, having in mind, among other things, how many other crossings will be affected, and how extensive will be the track and the various street changes.

It is sometimes considered proper to order grade crossing eliminations where the traffic is less dense than in other cases where the commission has refused to order elimination. Again, the commission, recognizing that grade separation must eventually be accomplished, may consider it proper to conclude its studies and to specify the mode of separation, leaving the actual performance of the work to some future time. The writer is now concluding the study of just such a case for this commission. There are eleven streets involved within a distance of two miles of railway line. The city wanted the tracks elevated; the railroad, while not admitting the necessity for grade separation, favored track depression for the benefit of grades affecting a heavy freight traffic. The city would not establish official street grades in many parts of the adjacent territory, with a consequent hindrance to improvement contemplated by its citizens. The industries, some of them, wished to expand or rebuild, and sought assurances from the railroad as to future swithing

arrangements.

In this case traffic data were not in themselves a deciding factor with the commission. While the traffic at the various crossings is not now dense enough to compel immediate action in the separating of grades, yet careful observation and study of existing conditions indicate, to the satisfaction of the commission, that a separation must be accomplished before many years. It was therefore deemed advisable to pass upon the petition and change uncertainty to certainty as to what the future will develop relative to these grade crossings. This will permit the city to establish official grades and enable citizens and industries to anticipate the proposed changes and adapt themselves thereto.

These traffic studies did, however, cause the commission to act upon its own motion and order the railroad to furnish immediate additional protection at some of the crossings involved, in the way of crossing gates and flagmen. A similar result follows, in fact, almost every traffic study made in connection with petitions for grade crossing elimination.

It must be understood that while the law specifies only the safety of the public as the basis upon which the commission can exercise jurisdiction in the matter of separation of grades, yet in practice the commission does consider other conditions before deciding as to the requirements for public safety. The number of accidents which have occurred; the amount of traffic and the inconvenience and delays to which it is subjected, and

especially delays to fire departments; topographical peculiarities which tend to increase the hazard; and the probable costs are all contributing factors in determining this question.

b. Mode and manner. Just as difficulties often increase as we journey through life, so is it with the subject in hand. In attempting to determine the mode and manner of affecting a separation of grades, difficulties and contentions surely will present themselves. Individuals and public alike refuse to change their lines of travel or habits or to allow themselves to be in any manner discommoded without a protest. And if accompanying such treatment is a financial burden, then indeed will the protest be most emphatic. Generally speaking, grade crossings can not be eliminated without materially changing the existing order of things, nor without the expenditure of somebody's money. And the more imperative the necessity, the greater the changes required, as well as the resultant cost.

Here indeed must each case be considered under its own conditions. The safety of the public is undoubtedly of paramount importance, but if that safety is duly provided for with reasonable and efficient facilities, the same public should not be too insistent as to the disposition of the railroad tracks. Track elevation will permit of a separation of grades with a less separation than will track depression, because the overhead clearance required for street traffic is less than that required for railroad traffic. Again, tracks generally can be elevated more easily, and with less expenditure of time and money than they can be

depressed. It is also true that industries adjacent to the proposed improvement can be more easily served with spur-track facilities from a track elevation than from a track depression. Then, why consider track depression at all? Simply because local topographical conditions may demand such a depression.

Consider the case mentioned just above, where the city desired that the tracks be elevated over the streets. To do so would introduce a very broken track profile with grades heavier than now exist. The railroad has a double track main line carrying a heavy freight traffic with a relatively light amount of local industry switching. It has recently completed an expensive cut-off adjacent to one end of the proposed improvement with a maximum grade of five-tenths of one per cent, which it is working to make the ruling grade for this freight division. The commission's engineers, after some preliminary studies, dismissed this plan and devoted their attention to a detailed study of track depression. The controlling points for maximum depression were located. They proved to be three in number, and were: the cut-off just referred to; a waterway with a considerable drainage area, which crossed the right of way at about the middle of the proposed improvement; and a subway at an important street some two miles beyond the limits of the proposed work.

With these points in mind each street was studied in detail, considering the existing grades, improvements on adjoining property, and more particularly the sewers. Many objections were continually being received against any material changes being

made in street grades; but some proposed changes had to be accepted. The existing side track and industry spur facilities had also to receive careful study, and maximum grades for such track approaches adopted. As a result, an overhead track clearance of but little over sixteen feet, maximum grades of three per cent for side track leads, and of fifty-four hundredths of one per cent for main tracks, were considered to be the best obtainable. No street grade will be introduced greater than now exists on the same street in that vicinity.

The question of drainage for the proposed railroad excavations had to be considered, as well as changing a suburban station handling some team track and less than car load freight business. In this case the station and house or team track will be semi-depressed. The character of the materials to be encountered in excavation was also considered as well as its ability to sustain foundation loads. And finally, the probable method of performing the work and of handling both street and railroad traffic was considered. Preliminary estimates of cost were then made, independent of similar estimates made by the railroad.

As finally determined upon, there will be two subways and six viaducts or overhead bridges. Estimates seemed to show that these subways could be built for less than overhead bridges; the consequential damages would undoubtedly be less; a trunk sewer was of such depth as to permit of the subways; and in either case the maximum approach grades would of necessity be five per cent. The two subways will be on one street, passing under two

double track main lines and near the junction of the above mentioned cut-off with the old main line. The street between these subways, some four hundred feet apart, must of necessity be depressed from sixteen to eighteen feet. Closely adjacent to one side of this portion of the street is an electric railroad on a high embankment and passing over these two lines of railroad on high trestles. On the opposite side of this proposed street depression is unimproved property assessed at about \$20 per front foot. The writer has proposed for this portion of the street between the subways, and for the approaches where the property is not now improved, that retaining walls be omitted and easements be secured permitting of slopes extending upwards and outwards from the depressed street lines. This will give the street more light and lessen the impression of being below the normal ground level. The cost of construction should be less and the consequential property damages are expected to be less than would be the case if retaining walls were to be built; and the appearance to an impression upon the users of the street would be more favorable.

That each case is a problem for special study can be illustrated by referring to other cases dealt with. In one such case the railroad climbed out of a river valley over a long uniform hill at approximately right angles to its axis, and with a grade such as to require pusher service for tonnage trains. This grade is a little over one per cent, while the ruling grade of the division is about seven-tenths of one per cent. The city

streets involved follow the surface of the ground closely and on very easy grades, because they are practically parallel to the axis of this long hill. Some are business streets while others are residential, but all are well improved and carrying a heavy traffic. The railroad, with two main tracks, has a very considerable amount of team track facilities on its right of way. It also has a passenger station and a freight house with a small freight and switch yard at the summit of the hill, and has on both sides of its tracks, and within the limits of the proposed grade separation, over eighty industries.

The aggregate delays to citizens crossing these tracks have reached a very considerable amount due to the large number of train and engine movements over the crossings, amounting to over one hundred and fifty movements per day in some cases, and the large number of street cars, vehicles, and pedestrians involved. During portions of the day the street cars operate on a four-minute headway.

There was no difficulty in arriving at an early understanding with the city as to which streets, eight in number, were to be provided for, and which now using crossings, three in number, should be closed. Twelve streets within these limits have never been opened across the tracks. But the manner of affecting the separation presented about as difficult a problem of its kind as the writer has had to contend with. A great amount of study and consideration was given the subject, during all of which time the attitude of the railroad was more or less openly

obstructive. At no time was its influence constructive. Furthermore, the relations between the railroad and the city were strained. The local industries organized, and under the opinion that any and all changes in their existing side track facilities would be at their sole expense, vigorously opposed any material change in track grades. The railroad took the position that a strict interpretation of Interstate Commerce Commission rulings against discrimination in service, rendered shippers, would prevent it from assuming any part of the financial burden incident to replacing industry side track facilities when disturbed by the proposed grade separation. It even went so far as to include in such expense all cost over and above that necessary to change the grades of its main tracks only. For instance, it maintained that if track depression were ordered, its right of way would permit the main tracks to be depressed with natural slopes. Therefore any additional excavation outside of, or beyond, these slopes, together with all walls, as well as the ramps and side tracks themselves within the right of way lines, would be at the sole expense of the industries; all in addition to such construction as would be required off its right of way.

To elevate the tracks in order to obtain all or nearly all, the vertical clearance necessary for the streets was impracticable for the reason that it introduced track grades greater than existing grades, already so heavy as to be a burden to the railroad. To either depress or elevate the streets to any extent would be to create artificial street grades considerably in

excess of existing street grades anywhere in that vicinity. And to affect the desired separation by a full street elevation or depression would affect such a total street length with its ramifications of side or cross street approaches and property damages that such a plan was seen to be impracticable.

To partially depress the tracks and partially elevate the streets could only be considered for the possible assistance it might be to the various industries in replacing their side track facilities. A careful study of the various industries and their track facilities revealed the fact that a considerable part of such service was taken from tracks entirely within the limits of the railroad right of way, and in many cases from various team tracks in use through this district. Furthermore it seemed apparent that most of these industries were not financially strong enough to invest any considerable sum in private track facilities. To so handle the streets and tracks as to permit of less expensive private track facilities when the commission could have no assurance that the industries would incur the expense of replacing old or constructing new private tracks, would be to saddle a bad street condition for all time upon the city, without a certainty of some corresponding benefit to other interested parties.

It was therefore considered best to provide for a full track depression with but little change in street grades, and it was so ordered. The commission has recognized in this case that a hardship will accrue probably to many industries. Some may seek new locations, while others may continue to use team tracks,

but with a longer team haul, while perhaps only a few may be expected to provide for private track service from the depressed main tracks. It might be of interest to state parenthetically that as a result of this order, influence was brought to bear which caused the last legislature to enact a statute which put upon the commission the duty of assuming jurisdiction in the matter of replacing industry tracks disturbed by reason of grade separation, and requiring it to determine the mode and manner of so doing, and to apportion the cost between the railroad, the municipality, and the industry. The law is retroactive as concerns all grade separation projects not finally completed on date of enactment.

In another city, when grade elimination of a double track line was about to be ordered, there was no argument as to the general method to adopt. Track elevation was seen to be the only feasible plan. But the railroad plans did not provide for as many subways as the city desired. In this case the studies of the commission's engineers have shown it to be desirable to require more subways than proposed by the railroad, although not so many as asked for by the city. By changing some of the proposed locations and also by opening up a new street four blocks in length and parallel to the tracks, it will be possible to meet most of the contentions of the city. These studies also showed it to be practicable, without raising the track grades proposed by the railroad more than one foot in places, to have most of these subways constructed without any street depression at

all, thus eliminating sumps in the subways, with the consequent drainage to be provided for.

In this particular case accessibility and directness of routes for users of the streets presented the greatest problem, and not the question of grades and consequential damages. The effect upon the freight house with its house and teaming tracks, and upon a junction with a branch line reaching to both the freight house yard and to the passenger station, also contributed to the problem. Most of the suggestions offered by the commission's engineers have been tentatively accepted by the railroad in its revised plans for the proposed grade separation. Some details to be incorporated in the commission's order, such as widths of roadways, track supports in the centers of the streets, and other items of construction will be in conformity with agreements entered into by the railroad and the city. In fact the commission should and does conform to agreements between all interested parties in making its orders, unless it feels that public safety and welfare require that it do otherwise.

One more illustration may be of interest. A freight and switch lead several miles in length, reaches to and ends in a dense business center of a large city at a water front. After entering the city limits it passes for one and one-half miles over a comparatively smooth and level territory, with many industries alongside its tracks, taking switching service. This vicinity is also a well built up residence district housing the many employees of these industries as well as of other industries in

various parts of the city. The freight line then passes over the edge of a river bluff, descending across the face of the bluff or hill for one and three-quarters miles to the low part of the city. The first three-quarters of a mile descending from the high land is on a nine-tenths of one per cent grade, with but few industries alongside. The balance of this grade is less, from seven-tenths to five-tenths of one per cent, and is lined with a storage yard of stub tracks and tracks for making up and breaking up trains.

The line then extends for one-half mile across the low land, terminating in stub team tracks two blocks long, parallel and adjacent to the dock line and only ten or twelve feet above water level. The balance of the line below the hill is occupied with a freight station with its house and team tracks, as well as with numerous and important switch leads and spurs to nearby plants. Some of these leads are virtually switch backs, and occupy a river front street below that part of the freight line descending across the face of the hill. Crossing the tracks on the low part are three busy streets, which immediately cross the river on swing bridges. These streets carry an exceedingly heavy traffic.

Farther up the line, at the foot of the nine-tenths of one per cent grade, are two street crossings about six hundred feet apart. These streets are at right angles, and both cross the river on bridges above the harbor limits and then ascend on grades of nearly six per cent to an intersection on the edge of

the river bluff, each crossing the railroad tracks at grade at about mid elevation. At the top of the nine-tenths of one per cent track grade is a grade crossing with an important city boulevard, and then come city street crossings at regular intervals, reaching to the city limits. There are seventeen streets involved in this part of the line, and most of these crossings are double crossings with the street angles nearly forty-five degrees each way; that is, the line intersects most of the streets at or near a street crossing.

Although a petition is before the commission for a grade separation reaching to the city limits, the demand is more urgent for relief from the end of the line at the water front to the boulevard on the hill, inclusive. And more particularly is it urgent because of the two crossings at the foot of the nine-tenths of one per cent track grade along the face of the hill. The city must renew these river bridges in the near future, and urges the commission to decide upon a definite plan for grade separation so as to permit of these new street bridges over the river being built at such elevations, and with such reasonable grades, as will conform to an order which is expected from the commission in that matter.

The writer has made a preliminary study of the case, and will state as briefly as possible those features which seem to be pertinent, and their relation to or effect upon a possible grade separation scheme, together with tentative conclusions. Although prompt relief was being asked for at one point only, it was

necessary to first determine where and what are the controlling points and features of the scheme as a whole, looking toward an ultimate grade separation of the entire district in the best manner possible. Considering first the downtown, or business district, it was seen that but little depression of either tracks or streets could be obtained because of the water level and sub-surface construction, such as sewers, water and gas mains, conduits, etc. To elevate the streets with the attendant vertical clearance over the tracks was deemed impracticable because of the necessity for raising the river bridges with their swing spans; because of the street and side approaches, extending even to the opposite side of the river and rendering these portions of the streets almost useless for adjoining property; and because the consequential damages would seem to be beyond all benefits to be obtained thereby.

Track elevation would mean at least a partial confiscation of track facilities, since the tracks are used mostly for teaming purposes, and there is not sufficient distance between adjacent streets to permit of ramps reaching to the necessary track level. There are no train movements over these particular crossings. Switching service covers all rail movements in this locality. It therefore seems that the safety and relief demanded for the street traffic might best be obtained here by leaving these grade crossings as they exist, and limiting rail movements over them to certain periods of the day not coinciding with the rush hours or peaks in the street traffic, and protecting such rail movements with a sufficient number of flagmen.

That portion on the highland will best be served by track elevation, when a separation of grades takes place, because the separation of track and street grades will be less in that case than with track depression; the right of way will accommodate more tracks on an elevation than in a depression; the industries can be served to better advantage from the elevated tracks; and the tracks are more easily carried over the street intersections than under them. This would require that the tracks at the two crossings at the foot of the nine-tenths of one per cent grade be raised as much as possible in order to climb from the low land to a track elevation on the high land, but it is found that these particular streets will not permit of raising the tracks at this point. These two streets, above described, can be carried out at the elevation of their intersection on the edge of the hill till they pass over the tracks, and provide sufficient overhead track clearance in each case if the tracks are not raised. The approaches can then extend over new river bridges built for the purpose with approach grades less steep than now exist on the streets at this point. If desired they can be made with two decks, the lower to connect streets at a lower level along the river fronts.

This will therefore require the nine-tenths of one per cent track grade to be increased to about one and three-tenths per cent in order to provide for a subway at the city boulevard on the edge of the hill. The balance of the proposed separation can then be accomplished later on by means of track elevation. In fact such a scheme will permit of any or all portions of the

plan, as described, being carried out at different times, or in any sequence, and without material addition to the total cost by so doing. This has been advanced as a tentative plan for the consideration of the interested parties. It is hoped that these references to particular cases will serve to illustrate the character of the problems to be dealt with in determining upon the mode and manner of affecting a grade separation.

c. Apportionment of cost. Much might be written upon this subject if it were considered desirable to tabulate various apportionments that have been made in different cases in the past, and legislative apportionments now existing on the statute books of some of our states. Such information might be considered of value as a precedent for future apportionments. But this matter is often most arbitrarily handled by those in authority, and specific actions which are not themselves produced by a logical solution of the problem presented should not be followed blindly. Nor should they be allowed to establish a paramount precedent for future apportionments.

What should be done is to apportion the cost on the basis of the benefits to be conferred, and the responsibility for the existing condition. This is the problem. And how are we going to solve it? Here is a definite rule to govern our conclusions. But how are we to arrive at those conclusions? Therein lies the difficulty. In a separation of grades it is impossible to show tangible financial or material benefits at all in proportion to the cost, much less to ascertain just who is benefited,

and to what amount. It is acknowledged that the intangible benefits are of a considerable amount, otherwise grade separation would not be carried on as extensively as is the case. As stated in considering the necessity for grade separation, the safety and convenience of the public is of paramount importance. But who can determine its value in terms of dollars, or determine what individuals, or group of individuals, comprise that public so benefited?

To refer again to the writer's experience. In one case the city employed a consulting engineer to assist in its attempt to show enough tangible financial benefit accruing to the railroad in question to support the city's argument before the commission for an increase in the commission's tentative apportionment to the railroad, and a corresponding decrease in the city's share. The effort failed to show such benefit, even to correspond to the tentative apportionment attacked. But the question must be decided, and in the most equitable manner possible. To do this, the estimated total costs, including consequential damages, should be the basis on which to work.

Some ten of our states have passed laws specifying what percentages of such total cost shall be borne by the railroad and by other interested parties; the other interested parties comprising any or all of the following, viz.; the city or municipality, the town, the county, the state, and the street railroad. The proportion so fixed by law to be carried by the railroad varies from fifty to one hundred per cent; by the city from noth-

ing to fifty per cent; by the town or the county from nothing ing to fifty per cent; by the state from nothing to twenty-five per cent; and by the street railroad from nothing to fifteen per cent, except that in one state (Ohio) it may be assessed up to fifty per cent of the city's share. Since in this state the maximum that can be assessed against the city is thirty-five per cent of the total cost, it is possible for the street railroad to be assessed up to seventeen and one-half per cent of the total cost.

It must be understood that these state laws governing apportionment have some latitude in their application; depending on priority of railroad or highway; on initiation of improvement by railroad, municipality, or state; and on whether the change is to be made in the railroad or in the highway. Is it believable that all of these state laws, varying so much in apportionment, have been evolved from a logical solution of the problem, and deal equitably with all parties at interest? If so, why is the apportionment, as fixed by law, different in the various states? Again, many of the states invest commissions with authority to make such apportionments, leaving them to deal with each case as seems to be reasonable and proper. In other states the cities are left free to conduct their own negotiations with the railroads. Again using Chicago as an illustration, it offers the greatest example of a city's power in such negotiations. It is perhaps without parallel in its ability to dictate the terms after compelling the railroads to conform to its demands. It makes the railroads do all the work at their own expense, while the city assumes the property

damages, which up to 1909 were less than one per cent of the total cost involved.

Apportionment of cost by order of a commission would seem to be productive of the best results. A decision by a body of competent, fair-minded men, more or less trained by performing the duties of a commissioner, and aided by a staff of experts and assistants, should prove to be as reasonable as could be expected in dealing with such complex cases. But let us discuss for a moment the subject of total cost, with which we are to deal. While it is true that the total resultant cost, including consequential damages, is the sum to be considered in making the apportionment, yet the actual separation of grades does not always necessitate an expenditure equal to the resultant total expenditure. If streets are materially improved; or street approach grades to subways or bridges made much less than is reasonably adequate by reason of the city's demands, thus affecting a greater street frontage with consequent property damage; or more expensive bridges over tracks or streets called for to satisfy the ideas of a particular city, such as clear spans over the entire street roadway in all cases, regardless of width, or a certain type of structure to harmonize with local surroundings; or any other phase of the work affecting the streets is more than reasonably adequate to permit of a convenient separation of grades, why should the railroad share in this additional cost, if any there is?

On the other hand, why should the city, or other interested parties, be compelled to pay for any new tracks or other

additional facilities or betterments introduced by the railroad at the time of affecting the grade separation? In short, all additions and betterments to existing facilities which, for reasons of economy or convenience, are made in conjunction with the work of separating the grades in question, should be at the sole expense of the party benefited thereby. Therefore, if apportionment is to be made on a percentage basis, applied to resultant cost, one of two methods must be followed. Either an inventory and valuation of existing properties to be affected, must be made, and an inspection then made of all material and labor applied throughout the time of construction in order to separate and show properly these items as chargeable to apportionment cost or to additions and betterments cost; or estimates must be made from plans showing existing and proposed conditions with sufficient accuracy to give the commission a fair idea of the relative cost of work necessary to separate grades under existing conditions, and of the cost of additions and betterments proposed. This information must then be given due consideration if it is desired to order a percentage apportionment of the total resultant cost.

The first method calls for the commission to require the inventorying, valuing, inspecting, and accounting to be done, or the interested parties must agree upon joint representatives to do it for themselves. To illustrate; a subsidiary line of the Pennsylvania Railroad Company affected a grade separation in Cleveland, Ohio, described in various engineering papers in 1914, which was handled in this way. By agreement between the interested

parties an inventory was made and then a distribution of work affected, and inspection and accounting provided for, and the resultant cost, less all cost for additions and betterments, divided, thirty-five per cent to the city and sixty-five per cent to the railroad. This is the maximum amount apportionable to the city by its state law. In this work the industries provided all their track facilities off the right of way at their own expense, and all utilities, privately owned, as well as street railroads, made the necessary changes in their properties also at their own expense.

It will be seen that these methods entail a very considerable amount of work if reliable results are to be obtained. Otherwise disputes and differences for the commission to settle must be expected, and these, as a rule, come after the work is performed. This precludes the possibility of the commission making an original check or inspection of labor and material used, and how used, and only makes such contentions the more difficult to handle. The writer has observed in several cases that where the commission, in order to expedite the completion of the work of separating certain highway grade crossings, has decided only upon the percentage of apportionment to be applied to the actual resultant cost, trouble followed. The bills rendered for adjustment of cost are invariably disputed and questioned in many ways. Was such work necessary or required under the order? Was all such material, labor, and use of equipment required, and are all the unit pieces and charges proper? Disputes of this character, arising after the work is completed, are difficult to adjust with

satisfaction to any one affected thereby.

It will further be noted that these two methods of preparing for a percentage apportionment do not indicate what might be a reasonable division of cost. That has still to be determined. It would seem that no better method has yet been found for this purpose than to rely upon the mature judgment of such a commission as has been outlined herein. It is recognized that the consensus of opinion is in favor of a percentage apportionment of total necessary cost, but it would seem that a more satisfactory method might be used in many cases. However, before dealing with such a method, consider first some of the objections to a percentage apportionment. Five such objections will be stated.

1. Few grade separations are affected without additional expenditures being made for additions and betterments.

2. The segregation of all items of expenditure properly chargeable to additions and betterments is not always accomplished with sufficient detail and accuracy to permit of proper support in rendering bills for settlement of apportionable cost.

3. In work of considerable magnitude and of different forms and classes, it is not unlikely that errors made in planning and executing the various parts of the work will cause contingent expenditures, adding materially to the cost. If such work is executed largely by one party, as is generally the case, the other party must pay its percentage of such contingencies. In short, it is made liable for a possible expenditure without an opportunity

to have used its energies to avoid or prevent the contingency.

4. The railroad is now subject to state and federal regulation, both requiring the valuation of its properties. A percentage apportionment of the resultant cost of a grade separation improvement requires it to invest money in various items outside the limits of its right of way or realty holdings, widely scattered, and representing various proportions of the total expenditures involved in such items. Further, these items are not, as a rule, pertinent to the business of a railroad, which is that of furnishing and selling transportation by rail. This adds to the difficulty of maintaining a proper and concise record of investments for use in future valuations to be made. Again, since the railroad's investment of capital in a grade separation improvement is not in itself a revenue producing investment, it is the more necessary that the railroad be able to produce supporting papers and vouchers for all such expenditures, when needed. Otherwise the commission may be unable to verify the investments claimed by the railroad.

5. A percentage apportionment precludes the possibility of a final settlement of apportionment questions until the work is completed and all bills for settlement rendered and accepted. This will not be for many months, sometimes years, after the commission's order in the matter has been issued. In the meantime, the personnel of the commission's staff, or of the commission itself, may change, and contentions arising in the final settlement of cost must be adjudicated without the assistance of those

responsible for the specific requirements embodied in the order.

With these objections in mind, consider the plan to be suggested, viz.: The execution of the work and the burden of the cost to follow the same lines. That is, the parties in interest will be required to execute certain parts of the necessary work and to bear the expense incident thereto. This will require careful consideration on the part of the commission, since the apportionment of the burden of cost is determined at the time the distribution of the work is decided upon. But the commission, before it can issue an order for apportionment of cost on a percentage basis, should have sufficient data and information available to enable it, with but little, if any, additional material, to follow this plan. If all the work can not be so divided as to meet the requirements of what seems to the commission to be a reasonable distribution of the financial burden to be imposed, then go as far as possible in this manner, and apportion the cost of the remainder of the work on a percentage basis. Or better, distribute all the work among the parties in interest, and then require such parties as are not sufficiently assessed in this manner to pay a fixed sum to the other party, or parties, in interest, such as will secure a reasonable division of the total estimated cost. This sum to be determined and fixed by the commission, based upon estimates of cost of the proposed work.

The simplest application of this method would be one in which conditions permit of a division of work and cost along the right of way lines, and those lines extended across the various

streets and alleys. In other words, "on and off the right of way". The writer has under observation a grade separation improvement now nearing completion in which the work and the cost was ordered divided in this manner. The city also bears the expense of all consequential damages. This is a track elevation improvement with shallow street depressions. In this case all controversy over the proposed apportionment of cost was settled before the construction was commenced, and no contention in this matter after completion is anticipated.

There is an objection, however, in ordering a distribution of cost on the basis of "on and off the right of way". If such a distribution is anticipated, the railroad may be expected to advocate a plan tending to throw work outside of its right of way by insisting upon as little change as possible in its tracks. The city, on the other hand, will insist that its streets are inviolate, and that all the change should be made in the railroad tracks. In the case mentioned in the discussion of the mode and manner of affecting a separation, where a reference is made to the obstructive attitude of the railroad involved, it is very probable that just such an apportionment was anticipated by the railroad. No, the entire project must be treated as a unit to be dealt with as will best conserve the streets, tracks, and adjoining properties, and then should follow the determination as to how the financial burden should be distributed.

This method can be applied satisfactorily, in most cases at least, after the mode and manner of affecting a separation

of grades is determined. This can be illustrated by reference to the first case cited in dealing with the manner of affecting a grade separation, which is a track depression project. Of the eleven streets involved, one town has one street and joins with another town on the center line of a second street; the second town is concerned with this second street, a third street entirely within its limits, and joins with a city on a fourth street; and the remaining streets are within the city. The first town with the least number of streets involved has the greatest track mileage affected, but also the least amount of industry track changes. The second town has the least track mileage affected, but the most extensive and the most difficult industry spur changes are within its limits. As previously stated, the writer prepared preliminary estimates which, together with various estimates furnished by the city and railroad for use in determining the mode and manner of affecting the proposed separation, were used also in arriving at a tentative distribution of cost between the railroad, the city, and the two towns, based upon a distribution of the work involved. This tentative plan has not yet been reviewed by the commission, however, and properly is not a matter for further discussion here.

The writer has prepared a tentative order in another case which calls for track elevation, and apportions the cost in this manner by a careful distribution of the work involved. This tentative order is now being reviewed by the commission, therefore details of this apportionment can not be given at this time. There are several benefits to be obtained from this method,

and six such benefits will be specifically mentioned.

1. Even if the order should require more time in preparation, the total amount of work required of the commission in the case in hand will probably be less than if a percentage apportionment is made, to be applied to resultant cost.

2. Practically all of the work for the commission precedes the order and the starting of actual construction, instead of a probable large amount of attention after the separation is completed, if apportionment is made on a percentage basis. Experience has shown that contentions are to be expected in cases of a percentage apportionment, after the work is completed. And unless the commission has exercised careful supervision of the work in progress, and insisted that the parties performing the work keep proper and sufficient records of the details such as to permit of an accurate separation of cost for apportionment and for additions and betterments, it may be called upon to deal with vexatious questions regarding final settlements, after the work is finished and such information difficult or impossible to obtain.

3. The parties in interest can make such changes, additions, or betterments as seems to them desirable when performing their work; if there is no conflict with any of the provisions of the order. It allows greater latitude to these parties in such matters, and in the handling of the work, and all without particular concern to the other parties in interest.

4. Questions relative to the equity or reasonableness

of the apportionment of cost are more likely to be raised and settled before the cost is increased, rather than afterwards.

5. Contingent expenses, which, like the poor, are always with us, but which can never be estimated accurately, are themselves distributed. That is, each party has an opportunity to exercise sound judgment and efficiency in the execution of its own work, or alone suffer the penalty if it fails so to do. A possible objection might be raised at this point to the effect that the railroad would be the only party in interest so organized and equipped as to undertake work of this character. But grade crossing elimination on any extensive scale is only required in cities of such size that they too would be prepared to handle such work as would naturally be assessed to them.

6. The lines of demarcation of the investments and physical improvements resulting therefrom, for all the parties in interest, are more distinct and more readily established, should future occasion require. Do not these advantages, in conjunction with the disadvantages of the full percentage method of apportionment as stated previously, seem to warrant a more general application of this method?

There remains to be mentioned the matter of consequential damages. This matter is left for negotiation between the parties in interest, or failing satisfactory negotiations, for adjudication in the courts. But the matter is not so easily disposed of in preparing estimates of cost upon which to base an apportionment. There are two ways in which it can be dealt with.

1. Estimate the cost of restoring the property in question to a condition of usefulness equal to that previously existing.

2. Leave the consequential damages only to be assessed on a percentage basis. The objections previously stated to the percentage apportionment do not apply with equal force to this item of cost because in any event there is no tangible asset in lieu of expenditures made in settlement of damages.

V. CONCLUDING REMARKS.

In conclusion it is pertinent to summarize briefly some of the principal points set forth in the preceding pages.

In deciding as to the necessity for a separation of grades involving a large expenditure of money, it must be remembered that the question of increased safety for life and limb of users of the public streets can not, alone, be the determining factor. It is proper to consider also the financial condition of the parties in interest, and the relative need for this proposed improvement, as compared with similar projects contemplated elsewhere which affect all or some of the same parties.

The project should be considered as a unit in determining the best plan for accomplishing the desired separation, and without reference to an apportionment of the entire cost. That plan should be adopted which will best conserve the existing streets, railroad tracks and facilities, and adjacent industries and property, as well as the facilities accorded the public, and with the minimum of cost consistent therewith. This does not mean that the plan with the least estimated cost is the one to adopt. Such a plan might be unreasonable and unsatisfactory to all parties in interest.

After deciding upon the manner of affecting a separation of grades, the commission should impose as few limiting conditions regarding details of the proposed work as is possible. Specify maximum or minimum conditions wherever feasible, giving the interested parties an opportunity to incorporate better conditions

than are considered reasonable by the commission, if they so desire. In other words, leave the greatest latitude possible for these parties to use their own ideas and standards regarding specific details if the same are not inconsistent with the general plan outlined by the commission, nor in conflict with any of the commission's adopted standards.

The resulting work should be distributed among the parties in interest along the same general lines as near as may be considered practicable and reasonable. The city should do all work made necessary in connection with its police, fire, and water department's appurtenances, whether within or outside of the railroad right of way limits. These public service departments are of such importance to the city's population that the reason for this is obvious. Owners of utilities, as a general rule, should be required to make, at their own expense, all changes in their properties or appurtenances made necessary by reason of the separation of grades. Owners of street and inter-urban railroads should also be required to make, at their own expense, all necessary changes in their tracks, and as a rule for one foot outside the limits of the rails. This should include generally all grading and pavement within vertical planes through these limits. In addition, it is sometimes necessary to require them to pay additional sums in money to other parties in interest in order to bring about what appears to be a reasonable apportionment of the total cost. With these exceptions, the railroad should perform all work in any manner tending to interfere with

or endanger its rail operations, or service being rendered to the public. This generally means all work within the limits of its right of way, except as above noted. The city should do the remaining work, together with adjusting claims for consequential damages, as a general rule.

One primary reason for apportioning any cost of grade separation against a city or municipality is that it tends to impress upon public sentiment a real responsibility to be borne in mind when agitating for an improvement of this character. It prevents the exercise of authority without responsibility. Who pays the enormous expenditures for track elevation ordered to be made by the City of Chicago? Surely not the railroad owners, as so many like to believe, but rather the patrons or users of the railroads, and to the uttermost parts of their rail systems. And as though to add insult to injury these same contributors have to pay taxes to the city on all such investments made, as well as to meet the fixed charges of interest and sinking fund reserves. In the final analysis all expenditures made by railroads for such non-revenue producing improvements must be paid by that part of the public buying railroad service and transportation, the greater part of which is very remotely, if at all, benefitted by the improvement. Therefore it would seem obvious that that part of the public surrounding such an improvement, and deriving a real benefit therefrom in the nature of increased safety and convenience in the use of its streets, and in increased taxes received from the railroad, should bear a considerable part of

the cost with the railroad. It is of small weight relatively, but it must be remembered that the state is a contributor to a slight degree by supporting a commission, with its staff, for the purpose of dealing intelligently with these problems.

Hence it would seem proper and expedient to apportion the cost in accordance with the distribution of work as given above, as nearly as may seem to be reasonable and equitable. If such a distribution of work does not result in a reasonable apportionment of cost, then secure the same by means of fixed sums of money, to be paid and received between the parties in interest, such as will produce the desired distribution of the total estimated cost. Such a method should result in as reasonable a distribution of the total resultant cost as may be expected by attempting to determine just what percentage of the total resultant cost is just and reasonable for the different parties in interest to bear.

To summarize in a concluding sentence. It is desirable to have the distribution of work, the apportionment of cost, and the responsibility for future maintenance all follow the same lines, preferably those of ownership. Because this can not be done in all cases is no proper reason for not following the plan in each case so far as is practicable, and the writer's experience makes him feel that this plan is more generally applicable than first thought would deem possible.

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